REMARKS

Claims 7 to 12, as amended, appear in this application for the Examiner's review and consideration. The amendments are fully supported by the specification and claims as originally filed. Claim 12 has been amended to change "-20.degree. C." to "-20°C." Therefore, there is no issue of new matter.

Claims 7 to 12 stand rejected under 35 U.S.C. § 103(a), as allegedly being unpatentable over Japanese Application Publication No. JP 10-176239 to Kashima et al. (Kashima) in view of Bates et al., "Quenching of Steel", Vol. 4 ASM Handbook Online (Bates), for the reasons set forth on pages 2 to 6 of the Final Office Action, and maintained for the reasons set forth on the continuation page of the Advisory Action. The Advisory Action stated that the comparative data submitted with the Amendment dated January 22, 2010, should be submitted in a Declaration under 37 C.F.R. 1.132.

In response, Applicants submit herewith the Declaration under 37 C.F.R. 1.132 of Dr. Hitoshi Asahi, a co-inventor of the presently claimed steel pipe. The Declaration of Dr. Asahi sets forth the differences between the presently claimed steel pipe and the steel pipe disclosed by the cited references.

The presently claimed steel pipe has a small occurrence of the Bauschinger effect, wherein a steel base material contains, by mass percent, 0.03 to 0.30 percent carbon, C, 0.01 to 0.8 percent silicon, Si, 0.3 to 2.5 percent manganese, Mn, 0.03 percent or less phosphorous, P, 0.01 percent or less sulfur, S, 0.001 to 0.1 percent aluminum, Al, 0.01 percent or less nitrogen, N, and a balance of iron and unavoidable impurities. The steel base material has a dual-phase structure substantially comprising ferrite structure and fine martensite dispersed at the ferrite grain boundaries. The steel pipe is heated at the austenite-ferrite dual-phase temperature region, and then quenched after a steel plate is shaped into a pipe.

In his Declaration under 37 C.F.R. 1.132, Dr. Asahi states that the presently claimed steel pipe is used in oil wells and gas wells where the steel pipe exhibits a small drop in compression strength in the circumferential direction after the steel pipe has been expanded in the circumferential direction. One of ordinary skill in the art will understand that a small drop in compression strength in the circumferential direction after the steel pipe has been expanded in the circumferential direction is a small occurrence of the Bauschinger effect. *See* the present specification, page 1, lines 10 to 14.

As stated by Dr, Asahi, the phenomenon known as the "Bauschinger effect" is well known to those skilled in the art. In the Bauschinger effect, when a tensile stress is applied to a steel article in a given direction to cause plastic deformation, and a compressive stress is then applied in the opposite direction, the tensile stress reapplied in the original direction causes plastic deformation to occur at a lower stress than the original yield strength. *See* present specification, page 1, lines 24 to 29. In the presently claimed steel pipe. the Bauschinger effect is minimized in the circumferential direction when the steel pipe has been expanded, i.e., exposed to a tensile stress, in the circumferential direction.

Dr. Asahi explains that, in recent years, steel pipe technology has been developed such that a steel pipe used in an oil or gas well is expanded 10 to 30 percent after drilling using expandable tubular technology. Expandable tubular technology reduces drilling costs by expanding the steel pipe which has been inserted into the well after drilling. The expansion of the steel pipe introduces high tensile stress in the circumferential direction, and the ground introduces a high circumferential compressive stress in the opposite direction. As a result, the Bauschinger effect on the steel pipe in such situations becomes a significant issue. *See* present specification, page 2, lines 29 to 36. The Bauschinger effect is greatly reduced with the presently claimed steel pipe.

In the presently claimed invention, a steel pipe with a small occurrence of the Bauschinger effect is fabricated from a steel plate comprising a steel base material containing, by mass percent, 0.03 to 0.30 percent C, 0.01 to 0.8 percent Si, Mn: 0.3 to 2.5 percent Mn, 0.03 percent or less P, 0.01 percent or less S, 0.001 to 0.1 percent Al, 0.01 percent or less N, and a balance of iron and unavoidable impurities. The steel base material has a dual-phase structure substantially comprising ferrite structure and fine martensite dispersed at the ferrite grain boundaries.

As stated by Dr. Asahi, it is important to understand that, in the presently claimed steel pipe, it is after a steel plate is shaped into the steel pipe that the steel pipe is heated at the austenite-ferrite dual-phase temperature region and then quenched. As a steel plate is formed into the presently claimed steel pipe, the presently claimed steel pipe is typically a seam welded ERW steel pipe having a uniform thickness.

The ratio of the proportional limit of the compression stress-strain curve in the circumferential direction of the steel pipe before expansion of the steel pipe and after expansion of the steel pipe by introduction of 10 to 30 percent of strain is 0.7 or more, and is defined as

$$(PL\text{-}a)/(PL\text{-}b),$$

where (PL-a) is the proportional limit yield strength after expansion of the steel pipe, and (PL-b) is the proportional limit yield strength before expansion of the steel pipe using a 0.05 percent offset yield strength.

As explained by Dr. Asahi, the ratio of the proportional limit,

(PL-a)/ (PL-b),

is called the "Bauschinger effect ratio." The higher the value of the Bauschinger effect ratio, the smaller is the occurrence of the Bauschinger effect. *See* present specification, page 8, lines 5 to 8. Again, the presently claimed steel pipe, has a small occurrence of the Bauschinger effect, which requires heating the steel pipe at the austenite-ferrite dual-phase temperature region and then quenching the steel pipe <u>after</u> a steel plate is shaped into the steel pipe.

In contrast to the presently claimed steel pipe, Kashima discloses a steel plate having a steel composition similar to the steel composition of the presently claimed steel pipe for use in the manufacture of a steel plate which can be shaped into a steel pipe. However, as stated by Dr. Asahi, Kashima does not disclose or suggest that <u>after</u> a steel plate is shaped into a steel pipe, the steel pipe is heated at the austenite-ferrite dual-phase temperature region and then quenched.

Bates was cited in the Final Office Action at page 3 for the disclosure that water is a convenient and pollution-free means to quench steel and that it is capable of creating cooling rates within the range taught by Kashima. However, as with Kashima, Bates does not disclose or suggest that <u>after</u> a steel plate is shaped into a steel pipe, the steel pipe is heated at the austenite-ferrite dual-phase temperature region and then quenched. Therefore, Kashima, whether taken alone or in combination with any other cited reference, doe not disclose or suggest that <u>after</u> a steel plate is shaped into a steel pipe, the steel pipe is heated at the austenite-ferrite dual-phase temperature region and then quenched.

As stated by Dr. Asahi, the presently claimed steel pipe has a small occurrence of the Bauschinger effect and a heat history in which, <u>after</u> the steel plate is shaped into a steel pipe, the steel pipe is heated at the austenite-ferrite dual phase temperature region and then quenched. Kashima and Bates, whether taken alone or in combination, fail to disclose or suggest the Bauschinger effect or a heat history equivalent to the heat history of the presently claimed steel pipe. Accordingly, the properties of the presently claimed steel pipe are significantly different from those of the steel pipe disclosed by Kashima and Bates.

In support of that position, Dr. Asahi provides the results of comparative tests with his Declaration under 37 C.F.R. 1.132. Copies of Figure A, B, and C submitted with the Amendment dated January 22, 2010, are attached to the Declaration of Dr. Asahi.

Figure A is a stress-strain diagram for a stress-strain test for a steel pipe in accordance with the present invention. Figure B is a stress-strain diagram for a stress-strain test for a steel plate of the type used to obtain the presently claimed steel pipe and of the type disclosed by Kashima. Figure C is a stress-strain diagram for a stress-strain test for a steel pipe in accordance with Kashima.

As stated by Dr. Asahi, the X-axis or strain axis for each of Figures A, B, and C are the same. In Figure A, the X-axis or strain axis is expressed as percent. In Figure B and C, the X-axis or strain axis is expressed as a non-dimensional decimal. Thus, it is readily apparent that the X-axis or strain axis of reach of Figures A, B, and C are the same.

In the comparative test provided by Dr. Asahi, a steel plate was produced having the following composition in mass percent: 0.086 percent C; 0.21 percent Si; 1.19 percent Mn; 0.018 percent P; 0.006 percent S; 0.03 percent Al; 0.0035 percent N, and a balance of iron and unavoidable impurities. The steel plate was produced by heating a steel slab at 1,230°C, hot rolling at a finish temperature of 870°C, cooling at a cooling rate of 20°/second, and then coiling at a coiling temperature of about 550°C.

In the comparative tests, the steel base material of the steel plate had a dual phase structure substantially comprising a ferrite structure and fine martensite dispersed at the ferrite grain boundaries. The fine martensite had an area ratio of 15 percent.

The steel pipe used to obtain the stress-strain diagram illustrated in Figure A was fabricated from the steel plate described above. Again, after the steel pipe was fabricated from the steel plate, the steel pipe was heated at the austenite-ferrite dual-phase temperature region and then quenched in accordance with the present invention. To obtain the stress-strain diagram, a test piece from the steel pipe was subjected to a stress-strain test. As illustrated in Figure A, the steel pipe, in accordance with the present invention, which, after being shaped into a pipe and then heated at the austenite-ferrite dual phase temperature region and then quenched, absorbs additional stress from a load after reaching the yield point stress. That is, the steel pipe of the invention exhibits plastic deformation or plastic working.

As illustrated in Figure A, the steel pipe of the invention does not begin to fracture after reaching the yield point stress. Instead, the steel pipe of the present invention exhibits plastic working after reaching the yield point stress. Thus, Figure A illustrates that the steel pipe of the present invention continues to absorb stress after reaching the yield point stress.

Figure B illustrates a stress-strain diagram for the steel plate described above. The steel plate was not subjected to the heat treatment required for the presently claimed steel pipe, and was not formed into a steel pipe. As result, the steel plate used to obtain the stress-strain diagram of Figure B is of the type used to obtain the presently claimed steel pipe and the steel plate disclosed by Kashima.

To obtain the stress-strain diagram of Figure B, a test piece of the steel plate was subjected to a stress-strain test. Figure B illustrates that a steel plate used to obtain the presently claimed steel pipe and a steel plate of the type disclosed by Kashima each absorbs additional stress from a load after reaching the yield point stress, and, thus, exhibits plastic deformation or plastic working.

Figure C illustrates a stress-strain diagram for a steel pipe fabricated from the steel plate described above. However, the steel pipe used to obtain the stress-strain diagram illustrated in Figure C was not heat treated and then quenched after the steel pipe was fabricated from the steel plate, as required in the presently claimed invention. Thus, the steel pipe used to obtain Figure C is of the type disclosed by Kashima that was not heat treated and then quenched after the steel plate was shaped into the steel pipe.

In the tests, a test piece from the steel pipe that was not heat treated was subjected to a stress-strain test that was substantially the same as the stress-strain test used to obtain the stress-strain diagram illustrated in Figure A. Figure C illustrates that steel pipe of the type disclosed by Kashima, which was not heat treated and then quenched after being shaped into a pipe, does not absorb additional stress from a load after reaching the yield point stress, and, thus, fails to exhibit plastic working or plastic deformation, as does the presently claimed steel pipe.

Instead, as illustrated in Figure C, a steel pipe of the type disclosed by Kashima begins to fracture immediately after reaching the yield point stress, and does not exhibit plastic working. As illustrated in Figure C, that the stress absorbed by a steel pipe of the type disclosed by Kashima reaches a maximum at about the yield point stress. The pipe then fails.

In conclusion, Dr. Asahi states that a comparison of the stress-strain diagram illustrated in Figure A for a sample of the presently claimed steel pipe, which was subjected to a heat treatment after shaping the steel plate into the steel pipe, and the stress-strain diagram illustrated in Figure C for a sample of pipe of the type disclosed by Kashima, which was not subjected to a heat treatment after shaping the steel plate into the steel pipe, clearly demonstrates that steel pipes shaped from substantially similar steel plates, but subjected to

different heat histories after the steel plate is shaped into the steel pipe, have significantly different stress-strain characteristics.

Thus, the stress-strain diagram illustrated in Figure A demonstrates that the steel pipe of the present invention provides a small occurrence of the Bauschinger effect after the steel pipe has been expanded, i.e., is subjected to circumferential tensile stress, for applications such as oil and gas wells. In contrast, the stress-strain diagram illustrated in Figure C demonstrates that the steel pipe of the type disclosed by Kashima does not provide a small occurrence of the Bauschinger effect after the steel pipe has been expanded. Therefore, one of ordinary skill in the art, following the teachings of Kashima and Bates would not obtain the presently claimed steel pipe, and Kashima and Bates, whether taken alone or in combination, fail to disclose or suggest the presently claimed steel pipe or provide any reason for one of ordinary skill in the art to make and/or use the presently claimed steel pipe.

Therefore, as Kashima and Bates, whether taken alone or in combination, fail to disclose or suggest the presently claimed steel pipe, and provide no reason for one of ordinary skill in the art to make and/or use the presently claimed steel pipe, the present claims are not obvious over those references. Accordingly, it is respectfully requested that the Examiner withdraw the rejection of claims 7 to 12 under 35 U.S.C. § 103(a) over Kashima in view of Bates.

Applicants thus submit that the entire application is now in condition for allowance, an early notice of which would be appreciated. Should the Examiner not agree with Applicants' position, a personal or telephonic interview is respectfully requested to discuss any remaining issues prior to the issuance of a further Office Action, and to expedite the allowance of the application.

No fee is believed to be due for the filing of this Amendment. Should any fees be due, however, please charge such fees to Deposit Account No. 11-0600.

Respectfully submitted,

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